1) Constraints for tune matching:

Refer to SAD manual:

Usage: (1) FIT [component]

(2) FIT component1 component2

sets the current location where the matching condition is applied. The component is given with the

form name[.order][{+-}offset] (see components). If component is omitted, the end of the beam line

is chosen.

If two components are given, it means a relative-fitting or zone-fitting. If the fitting condition

is not maximum-fitting, the condition means to make values at two components equal (for AX, BX, GMX,

AY, BY, GMY, EX, EPX, EY, EPY, R1, R2, R3, R4, DX, DPX, DY, DPY, PEX, PEPX, PEY, PEPY, CHI1, CHI2,

CHI3), or have the specified difference (for NX, NY, LENG, GX, GY, GZ). If the fitting condition

is maximum-fitting, the condition means a zone-fitting (for AX, BX, GMX, AY, BY, GMY, EX, EPX, EY,

EPY, R1, R2, R3, R4, DX, DPX, DY, DPY, PEX, PEPX, PEY, PEPY, CHI1, CHI2, CHI3), which suppress the

maximum of the function in the region between component1 and component2, or maximum-fitting for the

difference of the function (for NX, NY, LENG, GX, GY, GZ). The fit region is shown in the first

part of the prompt when FFSPRMPT is ON.

Examples: (1) FIT QF.2-10

sets the current fit point at 10 components upstream from the entrance of the second QF.

(2) FIT QF QD NX 0.5 BXM 10

sets the two-point fitting between QF and QD, then set the difference of NX between QF and QD to

be 0.5, and the maximum of BX to be 10 in the region between QF and QD.

FFS["FIT $$$ NX "//nux//" NY "//nuy];

* Fit target working point at {nux,nuy}

FFS["FIT QX4RE EX 0 EPX 0"];

* Fit horizontal dispersion and its’ prime to zeros at the location of QX4RE.

FFS["FIT QX4LE EX 0 EPX 0"];

* Fit horizontal dispersion and its’ prime to zeros at the location of QX4LE.

FFS["FIT PMID AX 0 AY 0 EX 0"];

* Fit alpha functions alpha\_x and alpha\_y, dispersion\_x to zeros at PMID.

FFS["FIT PKICKER1 PKICKER2 NX 0.5"];

* Fit horizontal phase advance between PKICKER1 and PKICKER2 to be 0.5\*(2Pi). This is a constraint for injection kickers.

FFS["FIT INJECTIO BX 100"];

* Fit the horizontal beta function at INJECTIO to be 100 m (INJECTIO should be the injection point)

! FFS["FIT QD1E.13 QD1E.14 AX 1 BX 1 AY 1 BY 1 EX 1 EPX 1"];

* This is commented out (not used in practical tune matching).

FFS["FIT PQD1C.5 PQD1C.6 AX 0 BX 1 AY 0 BY 1 EX 1 EPX 0"];

* I think this is a relative fitting between the 5th and the 6th PQD1C markers. The AX, AY, and EPX should be zeros at the two positions. The BX, BY, and EX should be equal at the two positions.

See output by SAD:

AX BX NX EX EPX Element Length Value s(m) AY BY NY EY EPY DetR #

8.6E-13 4.68439 25.7046 .22506 9.8E-14 -PQD1C.5 .0 0 1686.14722 6.1E-12 26.7155 23.6891 -4.E-12 -8.E-14 -1E-23 3453

-1.E-12 4.68439 26.8528 .22506 1.6E-13 PQD1C.6 .0 0 1761.81763 -5.E-12 26.7155 24.8124 -4.E-12 6.2E-14 -1E-23 3543

FFS["FIT PFBMON2 PFBMON1 NXM 0.3"];

* This is a zone-fitting: to fit the horizontal phase advance between PFBMON2 and PFBMON1 to be smaller than 0.3\*(2Pi). 0.3 is the maximum value.

FFS["FIT PFBMON2 PFBMON1 NYM 0.3"];

* This is a zone-fitting: to fit the vertical phase advance between PFBMON2 and PFBMON1 to be smaller than 0.3\*(2Pi). 0.3 is the maximum value.

2) Variables and their constraints used for fitting

{k1min=0.012,k1max=0.31},

* Minimum and maximum quadrupole magnet strength.

FFS["FREE QI\*E QX\*E QM\*E"];

* Free the magnets with their names containing “QI\*E QX\*E QM\*E” for fitting.

FFS["QI{246}\* MIN "//k1min//" MAX "//k1max];

* Set constraints of minimum and maximum K1 values for “QI{246}\*” magnets.

FFS["QI{357}\* MIN -"//k1max//" MAX -"//k1min];

* Set constraints of minimum and maximum K1 values for “QI{357}\*” magnets.

FFS["QX{246}\* MIN "//k1min//" MAX "//k1max];

* Set constraints of minimum and maximum K1 values for “QX{246}\*” magnets.

FFS["QX{357}\* MIN -"//k1max//" MAX -"//k1min];

FFS["QM{246}\* MIN "//k1min//" MAX "//k1max];

FFS["QM{357}\* MIN -"//k1max//" MAX -"//k1min];

FFS["FREE QS\*FRE"];

* Free “QS\*FRE” for tune matching.

FFS["QS{2B}FRE MIN "//k1min//" MAX "//k1max];

* Constraints.

FFS["QS{34}FRE MIN -"//k1max//" MAX -"//k1min];

FFS["FREE QS\*FLE"];

FFS["QS{2B}FLE MIN "//k1min//" MAX "//k1max];

FFS["QS{34}FLE MIN -"//k1max//" MAX -"//k1min]; ];

3) Note that the K1 of quadrupoles in SAD is the integrated strength. When translating to Bmad, the K1 should be K1/L with L nonzero the magnet’s length. If L=0, then SAD and Bmad use the same definition: K1 is the integrated strength.